Nuclear Innovation
North America LLC

Powering the Nuclear Renaissance:

ABWR Technology

FACT SHEET

ABWR Advantages at a Glance

- **Only advanced nuclear design in operation and certified by the U.S. NRC**
- **Only advanced nuclear design with four units fully engineered and built on time and on budget**
- **Substantial and greater certainty on critical factors such as cost, schedule, process, quantities and end result**
- **Lowest first-of-a-kind engineering and technology risk of any new nuclear technology**
- **Proven performance during twelve years of operations in Japan**

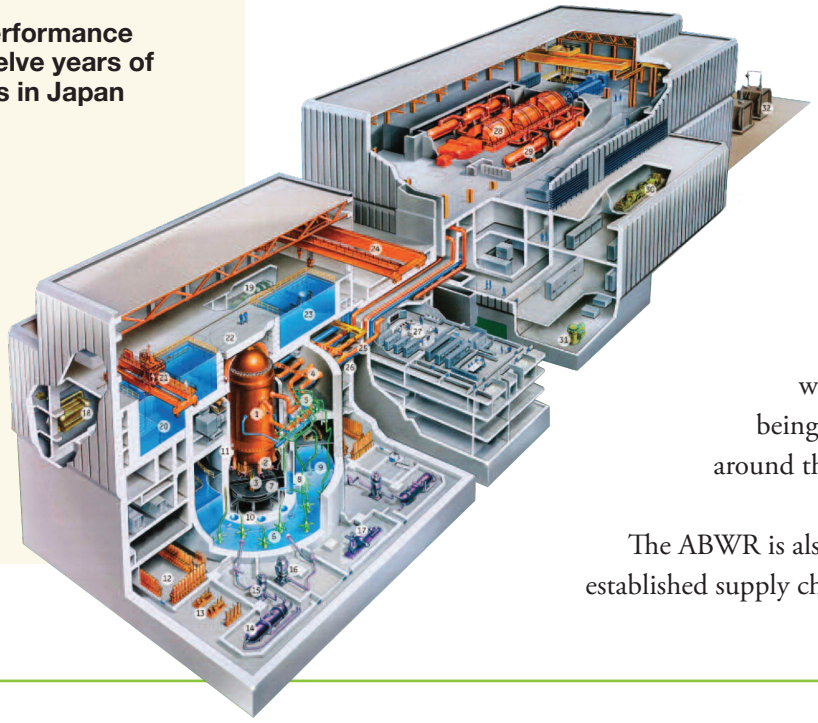
ABWR OVERVIEW

The combination of construction and operating history, few first-of-a-kind technology risks and a competitive supply chain provides the ABWR with a level of certainty unmatched by other advanced nuclear designs.

The Advanced Boiling Water Reactor (ABWR) is the only advanced nuclear design to have successfully entered operation. It has few of the first-of-a-kind technology risks found with all other advanced nuclear designs. The four ABWR units in commercial operations have been built in between 37 and 43 months from first safety concrete to first fuel load in Japan, and have more than a decade of operating history.

Nuclear Innovation North America (NINA) will use proven construction practices like those that have been perfected on Japanese ABWRs to achieve similar construction timelines.

TOSHIBA



The proven construction record of the ABWR gives it significant cost and schedule certainty compared to other advanced nuclear designs. Because no other advanced nuclear design has been constructed, only the ABWR offers the benefit of having known quantities of material and equipment and lessons learned from previous construction experience. It represents the best potential for successful replication within the U.S. just as it is currently being replicated in a number of countries around the world.

The ABWR is also able to take advantage of an established supply chain. The ABWR has been successfully

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ABWR OVERVIEW continued

built by both Hitachi and Toshiba with support from General Electric. Three ABWR units are under construction in Taiwan and Japan, and nine more units are planned in Japan with four in advanced development, and five in the early planning stages. Additionally, multiple vendors have ABWR capabilities in the U.S which should lead to a competitive pricing environment and help ABWR developers by ensuring the technology remains economically viable relative to other alternative generation technologies over the long term.

THE ABWR DESIGN

The ABWR is the evolutionary design of the last generation of Boiling Water Reactors (BWR) built in the U.S. It carefully blends the best features of worldwide operating BWR plants with new and improved safety and performance systems, while systematically reducing capital costs and incorporating features into the plant design that will make maintenance significantly easier and more efficient.

The ABWR design uses a single-cycle, forced circulation, boiling water reactor. The design incorporates the best features of the BWR designs in Europe, Japan and the U.S., and uses improved electronics, and computer, turbine and fuel technology, resulting in improved plant availability, operating capacity, safety and reliability.

One of the most notable safety improvements was the moving of the water circulation pumps inside the reactor which enhanced plant operations while lowering construction costs and radiation exposure to outage workers.

Other safety enhancements include:

- The use of more than 200 modules per unit to reduce construction duration, costs and rework
- A more robust, long-lived reactor pressure vessel using forged rings instead of welded plates
- Internal recirculation pumps to enhance safe operations while reducing plant size, cost, and maintenance
- More capable and multiple integrated emergency core cooling systems to protect against possible loss of coolant situations
- Greater operator control as a microprocessor-based digital control system and a mechanical, ball screw continuous drive system provide much finer adjustment of a control rod's position

ABWR IMPROVEMENTS OVER EXISTING BWR TECHNOLOGY

Feature	Constructability	Performance	Safety
Modularization	☑	☑	☑
Reactor Pressure Vessel	☑	☑	☑
Reactor Recirculation System	☑	☑	☑
Fine Motion Control Rod Drive System		☑	☑
Emergency Core Cooling System		☑	☑
Digital Control Systems		☑	☑
Turbine Generator		☑	

- A more thermally efficient, higher output turbine generator

The ABWR is truly an advancement over the units that are presently in operation in the U.S.

ABWR COMPARED TO OTHER ADVANCED NUCLEAR DESIGNS

The ABWR is unique relative to other advanced nuclear designs given that it is already certified by the U.S. Nuclear Regulatory Commission and has an established track record of commercial viability. The chart below provides a comparison of ABWR and other major advanced nuclear designs.

ABWR COMPARISONS TO OTHER MAJOR DESIGNS

Advanced Nuclear Designs		ABWR	EPR	APWR	ESBWR
Designed	■ Eliminates need for design changes in the field ■ Ensures engineering remains ahead of construction schedule ■ Certainty in performance versus theoretical or calculated	☑	☑	☐	☐
Supply Chain Established	■ Proven supply base ● Design and manufacturing process established ● Components proven to meet unit specifications ● Lead times and cost estimates are known ■ Mitigates multiple first-of-a-kind risks that increase cost and schedule	☑	☑	☐	☐
Constructed	■ Four operational units built in Japan within 37-43 months ■ Known quantities of labor, material and equipment ■ Proven unit modularization has increased modularization more than 100% from first units ■ Integrated team with substantial experience in ABWR construction	☑	☐	☐	☐
Operated	■ More than 12 years operating experience ■ Achieved capacity factors of more than 92% ■ Known O&M and CapEx costs ■ Startup and early operational issues identified and mitigated	☑	☐	☐	☐

ABWR Design Improvements

Modularization: ABWRs currently in development will use more than 200 modules, weighing up to 1,000 tons. Through modularization, ABWR reduces construction duration, costs and rework.

Reactor Pressure Vessel (RPV): The ABWR RPV is manufactured using forged rings instead of welded plates, eliminating 30% of the reactor vessel welds used in older nuclear designs, resulting in a more robust, long-lived RPV design with reduced in-service inspection requirements.

Reactor Recirculation System: Internal reactor recirculation systems have been used extensively in European BWRs and Japanese ABWRs to improve overall operations while reducing plant size, cost, maintenance and in-service inspection requirements as well as occupational radiation exposure during routine plant maintenance.

Fine Motion Control Rod Drive System (FMCRD): The ABWR mechanical, ball screw continuous drive system provides fine adjustment of a control rod's position, enhancing safety and reliability by providing operators with finer control capability than the hydraulic driven control rod systems in BWRs today. In addition, the ABWR's unique FMCRD design reduces occupational radiation exposure and shortens refueling and maintenance outage periods.

Emergency Core Cooling System (ECCS): The ABWR design and its ECCS protects against possible loss of coolant accidents. The internal reactor recirculation system removes the possibility of a large line break below the elevation of the reactor core while improving ECCS capability with two trains of the high-pressure core flooder system each having two injection points. With these enhancements to the ECCS, the ABWR has a lower core damage frequency as calculated by probabilistic risk assessment relative to older BWR designs.

Digital Control Systems: The ABWR's digital control system in use in all operating ABWR facilities in Japan provides enhanced capabilities for efficient and safe operation of the plant. The state-of-the art digital instrumentation and control systems afford an intuitive man-machine interface, sophisticated equipment monitoring capabilities, improved information management systems, and an advanced display technology to reduce routine workload and enhance operator performance.

Turbine Generator: The ABWR produces a greater amount of power with a higher thermal efficiency than a traditional BWR plant by using a larger-sized turbine with 52-inch turbine blades and an advanced moisture separator reheater.

Sources:

Toshiba Corporation | *www.toshiba.com*

General Electric | *www.gepower.com*

Nuclear Regulatory Commission (NRC) | *www.nrc.gov*

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